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Quality of life after adenotonsillectomy in children with obstructive sleep apnea: Short-term and long-term results

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ABSTRACT

Objective: To assess short-term and long-term changes in quality of life after adenotonsillectomy (T&A) in children with obstructive sleep apnea (OSA).
Materials and methods: Children aged 2–18 years old were enrolled. All subjects had clinical symptoms, overnight polysomnography diagnosis of OSA, and received T&A as treatment. Caregivers were asked to complete the OSA-18 survey before surgery, within 6 months after surgery (short-term), and more than 6 months after surgery (long-term).
Results: A total of 114 children were included (mean age, 7.0 ± 3.5 years; 75% boys). The mean OSA-18 total score was 71.5 ± 16.0 before surgery. After surgery, the mean OSA-18 total score was significantly decreased in both the short-term (40.3 ± 12.2, $p < 0.001$) and the long-term (42.0 ± 13.7, $p < 0.001$). All five OSA-18 domains were also significantly decreased during short-term and long-term postoperative follow up ($p < 0.001$). Short-term and long-term outcomes were compared. Mean OSA-18 total scores, sleep disturbance score, emotional distress score, daytime function score, and caregiver concerns score did not differ significantly between the short-term and long-term periods, while the physical symptom score was slightly higher in the long-term than the short-term period (9.7 ± 3.3 vs. 8.7 ± 3.0, $p = 0.02$). Additionally, the physical symptoms score was higher in the long-term period in the female ($p = 0.01$), older age (>6 years) ($p = 0.03$), and non-obese ($p = 0.04$) subgroups.
Conclusion: T&A improves short-term and long-term quality of life in children with OSA. Nevertheless, caregivers observed children with aggravation of physical symptoms of quality of life during long-term follow up, especially in the female, older, and non-obese subgroups.

1. Introduction

Obstructive sleep apnea (OSA) in children is a respiratory disorder characterized by upper airway collapse during sleep [1,2], and had a prevalence of 1–3% [3]. Diagnosis is based on clinical symptoms, physical examinations and sleep studies [1,2]. Polysomnography (PSG) is the gold standard for establishing the presence and severity of OSA [1,2,4]. Hypertrophy of the adenoid and tonsils are the main causes of OSA in children [2,5]. Adenotonsillectomy (T&A) thus is widely recognized as an effective first-line therapy for childhood sleep apnea [6–10].

The impacts of childhood OSA on quality of life have recently begun to attract growing research attention [11–14]. Measuring quality of life in children requires using self- or caregiver-administered instruments to quantify impact on emotional state, physical symptoms, and family interaction. Among quality of life measures, the obstructive sleep apnea 18-items Quality of Life Questionnaire (OSA-18) is a disease-specific tool widely applied to

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pediatric obstructive sleep disorders [10,12–14]. Pertinent studies found that pediatric OSA had significantly impacted quality of life [14–16]. Furthermore, children with OSA achieved significant short-term and long-term quality of life improvements after T&A, as documented by changes in OSA-18 scores [14,17,18]. However, demographic factors affecting short-term and long-term changes in quality of life after surgery have not been well studied and thoroughly understood.

This study elucidates short-term and long-term quality of life outcomes after T&A in children with OSA. It then investigates the trajectories of quality of life changes after surgery and elaborates whether postoperative quality of life changes be maintained over the long-term among different subgroups (that is, age, gender, adiposity, and disease severity).

2. Materials and methods

2.1. Study population

The study protocol and informed consent to undergo questionnaires were approved by the Ethics Committee of the National Taiwan University Hospital. From January 2011 to May 2013, children aged 2–18 years were recruited from clinics. Initially, our participants were recruited from the respiratory, pediatric, and otolaryngologic clinics. Children with symptoms suggestive of sleep-disordered breathing (including snoring, mouth breathing, daytime sleepiness, hyperactivity, or witness breath pause) were then sent to otolaryngologic clinic for historical (symptoms) and anatomical (adenotonsillar size) assessments [19]. Basic data, clinical history, physical examination were taken. The tonsils were graded using the scheme by Brodsky et al. [20] as follows: (grade I) small tonsils confined to the tonsillar pillars; (grade II) tonsils extending just outside the pillars; (grade III) tonsils extending outside the pillars, but not meeting in the midline; grade IV) large tonsils that meet in the midline. Adenoid size was determined based on the measure of adenoidal–nasopharyngeal (AN) ratio identified in lateral cephalometric radiograph. The AN ratio was measured as the ratio of adenoidal depth to nasopharyngeal diameter using the method of Fujioka et al. [21] Children with AN ratio ≥ 0.5 or tonsil grade ≥ 2 underwent T&A for the treatment of OSA. The weight and height of each child were measured, and used to calculate body mass index (BMI). Age and gender corrected BMI was applied for each child using established guidelines [22]. Obesity was defined as a BMI exceeding the 95th percentile for subject age and gender [22,23]. Historical and anatomical assessments for all subjects were evaluated by the same examiner (Hsu WC).

All children underwent preoperative PSG studies to confirm the diagnosis of OSA, which was defined as the apnea/hypopnea index (AHI) ≥ 1 event/h in the PSG studies [4–10]. The quality of life assessment was based on the OSA-18 survey, which comprised an 18-item caregiver completed questionnaire [12]. The exclusion criteria were (1) AHI < 1 event/h in preoperative PSG studies, (2) previous tonsil, adenoid, or pharyngeal surgery, (3) cranio-facial anomalies, genetic disorders, neuro-muscular diseases, cognitive deficits, or mental retardation.

2.2. Polysomnography (PSG)

All subjects completed overnight PSG studies before surgery. Over-night PSG (Embla N7000, Medcare Flaga, Reykjavik, Iceland) was performed in the sleep lab following a protocol described elsewhere [5,9,23–25]. The sleep stage and respiratory event were scored based on the 2007 American Academy of Sleep Medicine standard [26]. Obstructive apnea was defined as the presence of continued inspiratory effort associated with a >90% decrease in airflow lasting $\geq$2 breaths. Hypopnea was defined as a $\geq$50% decrease in airflow lasting $\geq$2 breaths associated with arousal, awakening, or reduced arterial oxygen saturation of $\geq$3%. The diagnosis of pediatric OSA was defined as the occurrence of an apnea/hypopnea index (AHI) $\geq$1 event/h in the PSG studies [4–10].

2.3. OSA-18 quality of life questionnaire (OSA-18)

All subjects completed the validated OSA-18 questionnaires before surgery, within 6 months of surgery, and more than 6 months after surgery. Franco et al. [12] first described OSA-18, and Kang et al. [25] cross-culture translated and validated the traditional Chinese version of the OSA-18 questionnaire. The OSA-18 survey, a caregiver-administered quality of life questionnaire, contains 18 items divided into five subscales: sleep disturbance, physical symptoms, emotional distress, daytime function, and caregiver concerns. Each item is scored with a 7-point ordinal scale. OSA-18 is graded to produce each item score, as well as additional scores for the five sub-scales, and total score. The OSA-18 total score is the sum of the 18 items and, thus ranged from 18 (no impact on quality of life) to 126 (major negative impact) [12,25]. According to Franco et al. [12], children with OSA-18 total scores below 60 imply a small impact on quality of life; scores between 60 and 80 imply a moderate impact; and scores exceeding 80 imply a large life quality impact.

2.4. Adenotonsillectomy (T&A)

Tonsillectomy was performed using the coblation method, while adenoidectomy was performed using the microdebrider-assisted method. All surgical procedures were performed in a single stage under general anesthesia with two days of hospitalization [9,27].

2.5. Statistical analysis

Data were analyzed using SPSS Statistics 21.0 (IBM Corporation, New York, United States). Continuous data were expressed in terms of mean and standard deviation, and categorical data in terms of number and percentage. Before and after surgery continuous data were compared using a paired-sample *t*-test. Meanwhile, short-term and long-term continuous data in all participants and subgroups were compared using the paired-sample *t*-test. Factors affecting short-term and long-term persistence of the quality of life after surgery were assessed by multivariable logistic regression. The level of statistical significance was set at a p value below 0.05.

3. Results

3.1. Study population

The final analysis included a total of 114 children. The mean age was 7.0 ± 3.6 (range 2–18) years. Boys comprised 75.4% (86/114) of the sample. Fourteen subjects were toddlers (1–3 years), 48 were pre-school age (3–5 years), 40 were school age (6–12 years), and 12 were adolescents (13–18 years). According to age and gender corrected BMI, 25 subjects were obese, while 89 were non-obese. Mean AHI in all subjects was 15.7 ± 21.4 (range 1–131) events/h before surgery. In terms of OSA severity, 43 children had mild OSA (AHI, 1–5/h), and 71 children had moderate-to-severe OSA (AHI, >5/h).

Initially, 114 children had preoperative and postoperative short-term OSA-18 survey. The long-term OSA-18 survey was complete in 89 of the 114 (78%) subjects of the initial cohort. The mean interval between preoperative OSA-18 survey and surgery was 47.0 ± 22.1 (median 41, range 13–98) days. Meanwhile, the mean interval between surgery and short-term OSA-18 survey was 49.2 ± 39.8 (median 32, range 6–169) days, while that between surgery

and long-term OSA-18 survey was 266.6 ± 76.3 (median 267, range 182–470) days. The mean interval between short-term and long-term OSA-18 survey was 230.6 ± 55.5 (median 199, range 169–385) days.

3.2. OSA-18 before vs. short-term after surgery

Table 1 shows the OSA-18 total scores before surgery and short-term survey after surgery in all subjects. The OSA-total scores were significantly improved after surgery in the short-term survey (71.5 ± 16.0–40.3 ± 12.2, $p < 0.001$). Table 1 lists the changes in the OSA-18 subscale. All five subscales of the OSA-18 survey showed significant improvement in short-term postoperative survey ($p < 0.001$). Meanwhile, score of sleep disturbance score reduced from 18.5 ± 5.1 to 7.5 ± 3.2 ($p < 0.001$), while the physical symptoms score decreased from 17.0 ± 4.2 to 8.7 ± 3.0 ($p < 0.001$). The scores of emotional distress and daytime function score decreased from 7.9 ± 3.8 to 6.2 ± 3.1 and 10.0 ± 4.1 to 6.7 ± 2.7, respectively ($p < 0.001$). Finally, the score of caregiver concerns reduced from 18.0 ± 4.9 to 11.7 ± 4.9 ($p < 0.001$).

3.3. OSA-18 before vs. long-term after surgery

Table 1 illustrates the OSA-18 total scores before surgery and long-term survey after surgery. Compared to the preoperative OSA-18 survey, the OSA-total scores remained significantly decreased after surgery in the long-term survey (71.5 ± 16.0–42.0 ± 13.7, $p < 0.001$). The changes in the OSA-18 subscale are shown in Table 1. All five subscales showed significant decreases in long-term postoperative survey ($p < 0.001$). The sleep disturbance score decreased from 18.5 ± 5.1 to 7.9 ± 3.7 ($p < 0.001$); the physical symptoms score decreased from 17.0 ± 4.2 to 9.7 ± 3.3 ($p < 0.001$); the emotional distress score and daytime function score decreased from 7.9 ± 3.8 to 5.9 ± 3.2 and 10.0 ± 4.1 to 6.9 ± 3.3, respectively ($p < 0.001$); and the caregiver concerns score decreased from 18.0 ± 4.9 to 11.7 ± 5.0 ($p < 0.001$).

3.4. OSA-18 short-term vs. long-term results

Table 1 compares the OSA-18 short-term and long-term scores. The short-term and long-term OSA-18 total scores did not differ significantly (40.3 ± 12.2 vs. 42.0 ± 13.7, $p = 0.25$), implying a long-term improvement in overall quality of life. For the short-term and long-term surveys, the mean score in the domain of physical symptoms was significantly higher in the long-term survey (9.7 ± 3.3 vs. 8.7 ± 3.0, $p = 0.02$), whereas the domains of sleep disturbance, daytime function, emotional distress, daytime function, and caregiver concerns did not differ significantly.

3.5. Subgroup analysis of OSA-18 short-term vs. long-term results

Table 2 lists comparisons between short and long-term OSA-18 results in all subjects and subgroups. Although the OSA-18 total scores were slightly higher in the long-term than in the short-term in all subjects and also in some subgroups, the total score differences between these two periods did not reach statistical significance. Further subgroup analyses thus were conducted to identify correlations between short-term and long-term differences in the OSA-18 five domains. The score of physical symptoms was higher in the long-term than the short-term survey in subjects who were female ($p = 0.01$), older (> 6 years) ($p = 0.03$), and non-obese ($p = 0.04$). The sleep disturbance score was also higher in the long-term than the short-term survey in older subjects (>6 years) ($p = 0.04$). Nevertheless, emotional distress, daytime function, and caregiver concerns did not differ significantly between the short and long-term survey in all subgroups.

3.6. Factors affecting short-term and long-term persistent quality of life

Table 3 demonstrates factors affecting the shot-term and long-term persistent quality of life (OSA-18 total score ≥ 60) after surgery. Of all participants, 6 children had the short-term persistent of quality of life after surgery, and 10 children had the long-term persistent quality of life. Based on multivariable logistic regression analyses, demographic factors, including age, gender, adiposity, or disease severity did not significantly contributed to the post-operative persistent quality of life. Of note, quality of life before surgery significantly correlated to the short-term persistent quality of life ($p = 0.024$) and slightly affected the long-term persistent quality of life ($p = 0.051$) after surgery.

4. Discussion

This study is a large study elaborating both the short-term and long-term impacts of T&A on quality of life in children with obstructive sleep disorders. Analytical results demonstrated that children with OSA achieved an improvement in quality of life after T&A in both the short-term and long-term. Another interesting finding was that, while short-term and long-term benefits of surgery were achieved, the score for the domain of physical symptoms was higher in the long-term, implying that caregivers perceive some recurrence of physical symptoms after surgery in their children despite long-term improvement in quality of life. Based on these findings, clinicians should note the potential for long-term changes in certain domains of quality of life; therefore, children with OSA require both short-term and long-term quality of life follow up after surgery.

Quality of life is now recognized as an important health measure in clinical medicine [11–17]. Clinicians and decision-makers should comprehend the diseases and their impacts on quality of life. Measuring quality of life involves using self- or caregivers-administrated instruments to qualify the impact of disease on emotional states, physical symptoms and family

Table 1
Comparisons of obstructive sleep apnea-18 total and domain scores.

	Pre surgery (1)	Post-surgery 1 (2)	Post-surgery 2 (3)	p value†		
				(1) vs. (2)	(1) vs. (3)	(2) vs. (3)
OSA-18 total score	71.5 ± 16.0	40.3 ± 12.2	42.0 ± 13.7	<0.001	<0.001	NS
(S) Sleep disturbance	18.5 ± 5.1	7.5 ± 3.2	7.9 ± 3.7	<0.001	<0.001	NS
(P) Physical symptoms	17.0 ± 4.2	8.7 ± 3.0	9.7 ± 3.3	<0.001	<0.001	0.02
(E) Emotional distress	7.9 ± 3.8	6.2 ± 3.1	5.9 ± 3.2	<0.001	<0.001	NS
(D) Daytime function	10.0 ± 4.1	6.7 ± 2.7	6.9 ± 3.3	<0.001	<0.001	NS
(C) Caregiver concerns	18.0 ± 4.9	11.7 ± 4.9	11.7 ± 5.0	<0.001	<0.001	NS

Note: Data were expressed as mean ± standard deviation. NS, not significant. OSA-18, obstructive sleep apnea 18 items survey. Pre surgery, pre surgery survey. Post-surgery 1, post-surgery 1st survey. Post-surgery 2, post-surgery 2nd survey.

† Using paired t test.

Table 2
Subgroup analyses for the OSA-18 short-term vs. long-term outcomes.

Subgroup	n	OSA-18 total score			Sleep disturbance (S)			Physical symptoms (P)			Emotional distress (E)			Daytime function (D)			Caregiver concerns (C)		
		Post1	Post2	p	Post1	Post2	p	Post1	Post2	p	Post1	Post2	p	Post1	Post2	p	Post1	Post2	p
All subjects	89	40.9 ± 12.2	42.0 ± 13.7	ns	7.4 ± 3.2	7.9 ± 3.7	ns	8.8 ± 3.2	9.7 ± 3.3	0.03*	6.2 ± 3.1	5.9 ± 3.2	ns	6.7 ± 2.7	6.9 ± 3.3	ns	11.7 ± 4.9	11.7 ± 5.0	ns
Gender																			
Male	66	41.0 ± 11.8	42.4 ± 13.9	ns	7.6 ± 2.9	8.0 ± 3.9	ns	9.1 ± 3.2	9.7 ± 3.4	ns	6.1 ± 2.8	6.0 ± 3.3	ns	6.5 ± 2.3	6.7 ± 2.9	ns	11.7 ± 5.1	12.0 ± 4.9	ns
Female	23	38.8 ± 13.6	41.0 ± 13.5	ns	7.0 ± 4.1	7.5 ± 3.2	ns	7.7 ± 2.2	9.5 ± 3.1	0.01*	5.8 ± 3.5	5.6 ± 2.7	ns	6.8 ± 4.0	7.5 ± 4.2	ns	11.4 ± 5.2	11.0 ± 5.2	ns
Age																			
< 6 years	44	41.9 ± 12.0	41.4 ± 13.7	ns	8.0 ± 3.5	7.9 ± 3.9	ns	9.2 ± 2.6	9.6 ± 3.7	ns	6.7 ± 3.2	6.3 ± 3.3	ns	6.7 ± 2.7	6.7 ± 3.0	ns	11.4 ± 5.0	11.0 ± 4.9	ns
≥ 6 years	45	38.9 ± 12.4	42.7 ± 13.9	ns	6.9 ± 2.9	7.9 ± 3.6	0.04*	8.3 ± 3.4	9.7 ± 2.9	0.03*	5.4 ± 2.6	5.5 ± 3.0	ns	6.4 ± 2.9	7.1 ± 3.5	ns	11.8 ± 5.2	12.5 ± 5.1	ns
Adiposity																			
Non-obese	70	39.1 ± 11.6	40.7 ± 13.7	ns	7.0 ± 2.8	7.6 ± 3.6	ns	8.6 ± 3.2	9.6 ± 3.4	0.04*	6.0 ± 3.0	6.0 ± 3.2	ns	6.1 ± 2.5	6.6 ± 3.2	ns	11.3 ± 5.1	10.9 ± 4.9	ns
Obese	19	45.2 ± 13.5	46.9 ± 13.0	ns	9.3 ± 4.2	8.9 ± 4.1	ns	9.2 ± 2.5	9.7 ± 2.9	ns	5.8 ± 2.7	5.7 ± 2.9	ns	8.1 ± 3.5	7.7 ± 3.6	ns	12.8 ± 4.8	14.8 ± 4.0	ns
SDB groups																			
AHI 1–5	34	40.4 ± 13.1	41.8 ± 14.5	ns	7.8 ± 3.9	8.3 ± 4.0	ns	8.9 ± 3.4	9.7 ± 3.4	ns	5.6 ± 2.6	5.7 ± 2.9	ns	6.6 ± 2.6	6.3 ± 2.7	ns	11.4 ± 4.5	11.9 ± 5.5	ns
AHI ≥5	55	40.4 ± 11.8	42.2 ± 13.4	ns	7.3 ± 2.8	7.7 ± 3.6	ns	8.6 ± 2.8	9.6 ± 3.3	ns	6.2 ± 3.2	6.0 ± 3.3	ns	6.5 ± 2.9	7.2 ± 3.5	ns	11.7 ± 5.4	11.7 ± 4.7	ns

Note: Data were expressed as mean ± SD; AHI, apnea/hypopnea index; OSA-18, obstructive sleep apnea 18 items survey; SDB, sleep-disordered breathing.
* Significant level was below 0.05. NS, not significant.

interaction. Both general and disease-specific instruments have been used to define the impact of pediatric OSA on quality of life [11,12,28]. The Child Health Questionnaire (CHQ) is a reliable tool for global quality of life measurement in children [28]. Previous investigations have used CHQ to compare health status among healthy children, children with OSA, and children with chronic disease [15,16,29]. Stewart et al. [29] and Georgalas et al. [16] showed that children with OSA had worse CHQ scores than healthy children, and scores in children with OSA resembled those in children with juvenile rheumatoid arthritis. Rosen et al. [15] reported pediatric OSA associated with poorer CHQ scores, particularly in domains related to physical health outcomes. Furthermore, disease-specific quality of life surveys enable physicians to quantify disease-specific changes in quality of life before and after the treatment, and thus are widely used. Several disease-specific instruments, including Obstructive Sleep Disorders-6 (OSD-6) [11] and OSA-18 [12] have been developed for childhood obstructive sleep disorders. OSA-18 is the widely used survey for pediatric OSA, and has been tested as an evaluative and discriminative instrument [30,31]. Additionally, surgical therapy with T&A in children with obstructive sleep disorders offers significant short-term improvement in life quality, as documented by changes in OSA-18 scores [17,18,32–34]. These quality of life gains after surgery were achieved in Caucasians [17,32] and in other races [18,33,34], and even in cases involving additional pharyngeal or nasal surgeries [35,36]. Our study agreed with previous studies in which total OSA-18 scores significantly decreased in the short-term after surgery, indicating T&A significantly improved quality of life in children with OSA.

Table 3
Factors associating with short-term and long-term persistent quality of life after T&A.

Predictor	Regression coefficient (B)	SE	OR (95% CI)	p value
Short-term (6 events)				
OSA-18 before surgery	0.30	0.13	1.35 (1.04–1.75)	0.024*
Male gender	−2.12	1.59	0.12 (0.01–2.72)	0.183
Age ≥ 6 years	−0.81	1.29	0.45 (0.04–5.57)	0.531
Obese	−1.55	1.62	0.21 (0.01–5.04)	0.337
AHI ≥ 5	−3.45	2.08	0.03 (0.00–1.88)	0.097
Long-term (10 events)				
OSA-18 before surgery	0.05	0.02	1.05 (1.00–1.10)	0.051
Male gender	0.42	0.87	1.53 (0.28–8.32)	0.625
Age ≥ 6 years	0.18	0.71	1.20 (0.30–4.76)	0.801
Obese	0.21	0.78	1.23 (0.26–5.72)	0.791
AHI ≥ 5	−0.69	0.77	0.50 (0.11–2.27)	0.369

Note: Persistent quality of life is defined as OSA-18 total score ≥ 60. SE, standard error; OR, odds ratio; CI, confidence interval; T&A, adenotonsillectomy.
* Significant level was below 0.05.

Emerging evidences asserts long-term benefits in children with obstructive sleep disorders after surgery [35–37]. Table 4 lists literature on long-term quality of life changes after T&A in children with OSA [37–42]. Two of these studies were conducted in the USA, while the remainders were conducted in Spain, Germany, Brazil, and the United Kingdom. The mean subject age ranged from 4.1 to 10.6 years, with sample sizes ranging from 20 to 104 participants. Tools for quality of life assessment included OSA-18 in four studies, CHQ in two studies and OSD-6 in one study. Long-term follow-up periods ranged from 6 months to 4 years. Pertinent studies continually reported that quality of life in children with OSA after surgery, as compared with that before surgery, significantly improved over both the short-term and long-term. However, children with OSA may experience aggravation of life quality during long postoperative follow up [38,43]. Mitchell et al. [38] stated that the OSA-18 domain of sleep disturbance, physical symptoms, and OSA-18 total scores were significantly aggravated in the long-term. Huang et al. [43] observed that the OSA-18 scores improved significantly at 6 months post-surgery, but worsened again at 36 months. This study demonstrated that post-surgery quality of life improves significantly both in the short-term (<6 months) as well as in the long-term (6–12 months). Notably, despite overall quality of life remaining unchanged, children experienced worsened quality of life in the domain of physical symptoms during the long-term survey. These findings suggested that caregivers perceive some recurrence of physical symptoms after surgery in their children. Physicians thus should also pay more attention to subtle physical condition changes in these children to ensure early detection of subsequent sleep problems and quality of life aggravations.

Little is known regarding postoperative quality of life changes in children with OSA among subgroups [43–48]. Mitchell et al. [44] stated that children with both OSA and mild sleep-disordered breathing (SDB) achieved considerably improved quality of life after surgery. Furthermore, Mitchell et al. observed that both obese and normal-weight children achieved significantly improved OSA-18 scores after surgery. Additionally, obese children had worse OSA and quality of life before surgery than non-obese children, and were also more likely to have persistent OSA and poor quality of life after T&A [32,45]. These findings were consistent with this study, since children exhibited improvements in quality of life despite differences in disease severity and adiposity. Previous literature focused on subgroup analyses of short-term results in children treating with T&A. In contrast, this study focused

Table 4
Literatures of short and long-term QOL outcomes in children with OSA undergoing T&A.

First author/year	Country	Mean age (years)	Case number	M:F	Measure	1st survey Short-term	2nd survey Long-term	Response rate	Main outcomes
Flanary/2003 [37]	USA	6.0	57	26:31	OSA-18 CHQ-PF28	3 weeks	6 months	60%	QOL improved short and long-term
Mitchell/2004 [38]	USA	6.7	34	27:7	OSA-18	<7 months	9–12 months	57%	QOL improved short > long-term
Díez-Montiel/2006 [39]	Spain	4.1	104	37:67	OSD-6	8 days	3 years	NR	QOL improved long-term (>3 years)
Fischer/2006 [40]	German	6.2	20	13:7	OSA-18 BS	7.5 weeks	14.8 months	100%	QOL improved short and long-term
Lima Júnior/2008 [41]	Brazil	6.5	48	21:27	OSA-18	30 days	11 months	71%	QOL improved long-term
Randhawa/2011 [42]	UK	10.6	37	19:18	CHQ-PF28	3 months	4 years	89%	QOL improved long-term (4 years)
Our study	Taiwan	7.0	114	86:28	OSA-18	<6 months	>6 months	78%	QOL improved short and long-term

Note: BS, Brouillette Score; CHQ-PF28, children's health questionnaire parent form-28; NR, not reported; OSA, obstructive sleep apnea; OSA-18, obstructive sleep apnea 18 items survey; OSD-6, obstructive sleep disorders 6 survey; QOL, quality of life; T&A, adenotonsillectomy.

on demographic factors influencing long-term aggravation of disease-specific quality of life. Based on the long-term subgroup analyses conducted in this study, children who were female gender, older (>6 years), and non-obese exhibited aggravation in the quality of life domain of physical symptoms. Older children also displayed a change in the domain of sleep disturbances in the long-term survey. These findings indicated that caregivers are prone to perceive physical changes in the case of female, older, and non-obese children. Interestingly, this period coincided with 'puberty' with its associated dramatic changes in physical conditions. The physical changes during this period including growth spurt [49], change in body proportion [50], and maturation of secondary sex characteristics [51]. During puberty, hormones signal the body to grow faster, explaining why physical changes differ between genders. The growth spurt starts at around age 11 for girls and 13 for boys [49,50]. Thus, girls become generally taller than boys during these years, though boys often catch up and generally end up taller. Another change during this period happens in how the body is proportioned. Before puberty, the bodies of girls and boys are very similar. During puberty, muscle and fat tissue increase and are redistributed in ways that give girls and boys more adult-like appearances. For instance, fat moves from the middle to the upper and lower body for girls, giving them a curvier appearance [51,52]. All these findings provide possible pathophysiology to explain why caregivers paid special attention to the morphological changes of their children, leading to a higher score for the domain of physical symptoms in the long-term period.

This study has certain limitations. First, it lacked a randomized control group. Although T&A was the first line and most effective therapy for pediatric OSA [6–9], recent studies have suggested watchful waiting may be a reasonable treatment option and may result in a certain degree of improvement in quality of life [10,53]. Second, the dropout rate was 21%, and the extent of the improvement in quality of life for these subjects obviously was not determined. Third, the follow up period may not be long enough to thoroughly understand the natural course of the disease from childhood to adulthood [53,54]. We acknowledged that the natural history of the disease may play a role in the resolution or aggravation of certain symptoms, and hence may influence changes in quality of life among these children.

5. Conclusions

The OSA-18 questionnaire is a useful, patient-reported quality of life measure for health service research and clinical care in pediatric OSA. T&A, the definite treatment for OSA, significantly improves quality of life in children with OSA, as demonstrated by changes in OSA-18 score. These benefits were realized over both the short-term and long-term. Although caregivers have observed some recurrence of physical symptoms after surgery in their children, particularly in those who are female, >6 years, and non-obese, they nevertheless perceive a long-term improvement in quality of life.

Conflicts of interest

The authors declare no conflicts of interest.

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